Mucogingival Considerations in Orthodontic Treatment

Jan L. Wennström

Alterations in the mucogingival complex will occur during orthodontic tooth movement, but these are independent of the apico-coronal width (height) of the gingiva. The integrity of the periodontium can be maintained during orthodontic therapy also in areas that have only a minimal zone of gingiva. In terms of changes in the position of the soft tissue margin and in gingival dimensions, the important factors to consider are the direction of the tooth movement and the bucco-lingual thickness of the gingiva. Lingual tooth movement will result in an increased bucco-lingual thickness of the tissue at the facial aspect of the tooth which results in coronal migration of the soft tissue margin (decreased clinical crown height). Facial tooth movement, on the other hand, will result in a reduced bucco-lingual tissue thickness and thereby a reduced height of the free gingival portion and an increased clinical crown height. The risk for development of recession type defects in conjunction with orthodontic tooth movement is present only if the tooth has been moved out of the alveolar bone housing, ie, when an alveolar bone dehiscence has been created. (Semin Orthod 1996;2:46-54.) Copyright © 1996 by W.B. Saunders Company

A
necdotal data, as well as results from clinical and experimental studies, have documented that most forms of orthodontic therapy are innocuous to the periodontium. Hence, appropriately applied orthodontic forces do not result in permanent damage to a healthy periodontium, despite clearly defined structural changes during the active phase of tooth movement. However, an altered position of the tooth may bring about changes in the dimensions of the gingiva and in the position of the soft tissue margin (clinical crown height), and some patients may respond to labial movement of incisors and lateral movement of posterior teeth with gingival recession and loss of attachment.1-2 Since it has been claimed that recession type defects may develop during orthodontic therapy involving teeth that have an inadequate zone of gingiva,3-5 it has been recommended that in areas where the width of gingiva is less than 2 mm, a grafting procedure to increase the gingival dimension should precede the initiation of orthodontic therapy. There are consequently two aspects to be discussed in relation to the effect of orthodontic tooth movement on the mucogingival complex, namely:

1. Alterations in gingival dimensions and the requirement of a certain gingival width for the maintenance of the integrity of the periodontium and
2. Changes in the position of the soft tissue margin and the development of soft tissue recessions.

Gingival Dimensions

The position in which a tooth erupts through the alveolar process and its eventual position in relation to the bucco-lingual dimension of the alveolar process have a profound influence on the amount of gingiva that will be established.
around the tooth. Accordingly, if a tooth is erupting in a labial position in close relationship to the mucogingival line (Fig 1), only a minimal width, or complete lack of gingiva will be found on its facial aspect. Since the prevailing opinion has been that the nonkeratinized and loosely attached lining mucosa is incapable of serving as a defense barrier for the underlying connective tissue attachment to the root, and that a certain apico-coronal width of gingiva (gingival height) is necessary for proper protection, it has been argued that the width of gingiva has to be increased by surgical means over teeth erupting in such a position. However, before a decision is made to surgically increase the gingival zone, one should carefully consider the biological events that take place during the development of the dentition. In the child the gingival dimensions will increase because of growth in the alveolar process and changed position of the teeth in the alveolar process. Longitudinally monitoring of the gingival dimensions at the facial aspect of anterior teeth in the developing dentition has shown that a significant increase of the gingival height will take place. Also, the spontaneous change of the tooth position in the bucco-lingual direction that often occurs during the development, will affect the gingival height. Hence, a more lingual positioning of the tooth results in an increase of the gingival height (decreased clinical crown height; Fig 2), whereas the opposite will be the case when a tooth moves to a more facial position in the alveolar process.

Figure 1. A mandibular canine erupting in a facial position which has resulted in a minimal width of gingiva. Poor plaque control and obvious signs of gingival inflammation are evident.

Figure 2. Schematic illustration of the dimensional alterations in the periodontal tissues on the facial aspect of a tooth moved lingually.

There are basically two factors that may explain this alteration in gingival height: (1) a change in the height of the free gingival portion caused by a change in bucco-lingual thickness of the gingiva and (2) a change in the distance between the genetically defined position of the mucogingival junction and the tooth surface. Clinical and histological evaluations of the dimensions of the free gingiva indicate that there is a ratio of about 1:1.5 between its thickness at the level of the most coronal fiber attachment to the root and its height. A tooth facially positioned often shows an alveolar bone dehiscence with a thin covering soft tissue, but when moved in a lingual direction into a more proper position within the alveolar process, the tissue dimensions on its facial aspect will increase in thickness, which in turn results in an increased height of the free gingiva and a decreased clinical crown height. Furthermore, because the mucogingival line is a stable anatomical landmark that cannot be permanently altered by apically positioned flap surgery, and because the gingiva is anchored to the supracrestal portion of the root and therefore will follow the tooth during its movement in a lingual direction, the consequence is that the distance between the apical border of the gingiva, the mucogingival line, and the tooth surface will increase, i.e., an increased gingival height.

Surgical wounding of the tooth bordering soft tissue may also influence the dimensions of the gingiva. Healing of the periodontal wound is characterized by the formation of a granulation
tissue over which epithelial cells migrate from surrounding gingiva and/or alveolar mucosa. Whether keratinization of the covering epithelium will occur is determined by the properties of the connective tissue from which the granulation tissue originates.\(^\text{1-13}\) Granulation tissue derived not only from the remaining or adjacent gingiva, but also from the periodontal membrane, will form a tissue in the wounded area which in most respects, clinically as well as histologically, is similar to that of a normal gingiva, ie, a dense collagen-rich connective tissue lined by a parakeratinized epithelium.

It has been noted from a number of case reports, however, that if a tooth is erupting in a facial position through the alveolar mucosa, no gingiva will form adjacent to the tooth surface. The fact that a zone of gingiva invariably regenerates after surgical removal of the entire portion of this tissue,\(^\text{1}\) seems to be contradictory to the observation that no gingiva is formed when the tooth spontaneously erupts through the alveolar mucosa. A likely explanation of this contradiction regarding the establishment of a gingival zone may be that, when the tooth during the eruption penetrates into the oral cavity, the reduced enamel epithelium and the epithelium of the alveolar mucosa fuse at the edge of the tooth. This means that no wounding of the connective tissue occurs and, consequently, no granulation tissue formation can take place originating from the periodontal membrane. The marginal soft tissue on the facial aspect of the erupting tooth will therefore be composed of the loose connective tissue of the alveolar mucosa and covered by a nonkeratinized epithelium. If, on the other hand, a wound is created that allows the formation of a granulation tissue derived from the periodontal membrane, a zone of gingiva will be formed during healing.\(^\text{1}\)

The understanding of these biological concepts is of importance from a treatment point of view. If a tooth has an erupting position which may result in the positioning of its facial aspect within the alveolar mucosa, one should consider the possibility of surgically uncovering the tooth before it breaks through the mucosa. Such a treatment approach will establish a proper collagen-rich, keratinized border tissue around the tooth and will prevent the development of a potential mucogingival problem. Furthermore, taking into account the fact that the gingival dimensions will increase because of growth in the alveolar process and that teeth will often change their position in a bucco-lingual direction in the developing dentition, mucogingival problems such as recession type defects will often be eliminated spontaneously in the growing child (Fig 3), provided adequate plaque control is established and maintained.\(^\text{15-17}\) Consequently, reparative surgical treatment of recession type defects in the developing dentition may not be necessary and should therefore be postponed until growth is completed.

Figure 3. (A) Facial view of the lower incisor tooth region in a 9-year-old boy. The right central incisor has erupted in a facial position and close to the mucogingival line. There is an increased clinical crown height caused by loss of gingival tissue. The soft tissue margin shows pronounced signs of inflammation. The gingiva on the buccal aspect of the other incisors has a larger width and shows no signs of inflammation. Instructions were given in adequate plaque control measures. No surgical intervention was performed because the boy was still growing. (B) The same tooth region at the age of 14. Healthy gingiva and a more coronal positioning of the soft tissue margin is evident compared with 5 years earlier. The potential mucogingival problem has been resolved through plaque control and natural growth.
Requirement of a Certain Gingival Dimension

For many years the presence of an adequate zone of gingiva was considered critical for the maintenance of gingival health and for the prevention of continuous loss of connective tissue attachment.\(^\text{18}\) A concept thus prevailed that a narrow zone of gingiva was insufficient to (1) protect the periodontium from injury caused by friction forces encountered during mastication and (2) dissipate the pull on the soft tissue margin created by the muscles of the adjacent alveolar mucosa. Moreover, it was believed that an inadequate zone of gingiva would facilitate subgingival plaque formation as well as the apical spread of plaque-associated gingival lesions.

The opinions expressed regarding the requirement of a sufficient width (height) of gingiva for the maintenance of the integrity of the periodontium, however, were based mainly on clinical experience and poorly substantiated by scientific evidence. Clinicians had the impression that sites with a narrow zone of gingiva were often inflamed, whereas the wide zone of gingiva found at neighboring tooth surfaces remained healthy (Fig 4A). Additional support for this clinical impression was obtained from cross-sectional examinations showing that a correlation existed between the presence of recession defects and decreased width of the gingiva.\(^\text{19}\) In this context it must be realized, however, that data derived from cross-sectional studies cannot prove or disprove a cause-effect relationship. Consequently, data reported from such studies may also be interpreted to show that the formation of a recession defect results in a reduction of the width of the gingiva.

The study by Lang and Loe\(^\text{20}\) on the significance of gingiva for periodontal health concluding that, "2 mm of keratinized gingiva (corresponding to 1 mm attached gingiva) is adequate to maintain gingival health," has been widely quoted as a definition as to what constitutes an adequate width of gingiva for the maintenance of periodontal health. However, results obtained from more recent experimental studies, as well as longitudinal studies, in patients showing areas with a minimal zone of gingiva\(^\text{18}\) have all failed to generate support for this definition. In fact, the conclusion that can be drawn from these studies is that a certain quantity of gingiva does not seem to be essential for the maintenance of periodontal health and the preclusion of recession. It was also shown from longitudinal studies that the incidence of recession in areas without an attached portion of gingiva was not greater than that observed in areas with a wide area of attached gingiva,\(^\text{21-24}\) nor that the development of soft tissue recession will result in a decreased width of the gingiva.\(^\text{23}\) Hence, the traditional concept that a certain apico-coronal dimension of gingiva is critical for the protection of the periodontium proper has not been supported. The European Workshop on Periodontology
held in 1993 reached the consensus that, “surgical treatment with the sole purpose of increasing the apico-coronal width of the gingiva to maintain periodontal health and prevent the development of soft tissue recession cannot be considered justified.”

Localized gingival recessions are often found at malaligned teeth that have a buccally deviated position of the root with an accompanying alveolar bone dehiscence. Such predisposing alveolar bone dehiscences may also be induced by orthodontic tooth movement. Although many etiologic factors have been proposed for localized gingival recessions (eg, trauma from occlusion, frenum attachments, impingement of restorative margins, orthodontic forces), trauma caused by toothbrushing and gingival lesions associated with bacterial plaque must be considered to be the dominating causative factors in orthodontic patients also (for review see).

**Orthodontic Tooth Movement—Soft Tissue Alterations**

Similar alterations in the gingival dimensions and position of the soft tissue margin, as previously discussed in relation to spontaneous tooth movement, will also occur following orthodontically induced tooth movement. As mentioned previously, it has been postulated that an alveolar bone dehiscence is a prerequisite for the development of a recession defect; ie, a root dehiscence may establish an environment which, for one reason or another, is conductive also for loss of gingival tissue. With respect to orthodontic therapy, this would imply that as long as a tooth is moved exclusively within the alveolar bone, soft tissue recession cannot develop. On the other hand, because such predisposing alveolar bone dehiscences may be induced by uncontrolled facial expansion of teeth through the cortical plate, orthodontic treatment can create a situation that renders the teeth liable to development of recession defects. In this context, experimental studies have shown that labial bone will reform in the area of a dehiscence when the tooth is retracted toward a proper positioning of the root within the alveolar process. It is therefore likely that the reduction in recession seen at a previously prominent positioned tooth, which has been moved into a more proper position in the alveolar process, is also accompanied with bone formation (Fig 5).

Experimental studies in monkeys have noted that facial tipping, extrusion movements, and bodily movements of incisors will result in recession of the labial gingival margin and loss of attachment. However, similar studies performed in dogs or humans failed to show that labial tooth movement is accompanied with gingival recession and attachment loss. This discrepancies in the response of the marginal soft tissue to orthodontic therapy in the studies

![Figure 5](image-url)

**Figure 5.** (A) Facial view of an upper right canine in a 22-year-old woman at which the recession increased in depth after the initiation of the orthodontic therapy. Note the healthy gingival condition despite only very narrow gingival height at the buccal aspect. An abrasion defect is evident in the root surface. The tooth brushing technique was adjusted to minimize the trauma to the tissue. Because the tooth was planned to be moved in disto-lingual direction, surgical correction of the recession defect was postponed until completion of the tooth movement. (B) The tooth after completion of the orthodontic therapy. Note the reduction in the recession and the increase of the gingiva zone that has taken place as a consequence of the changed position of the tooth.
referred to are difficult to explain but may be related to differences with respect to (1) the amount of labial tooth displacement, (2) the magnitude of force applied, and/or (3) the presence/absence of plaque and gingival inflammation in the regions subjected to tooth movement. It was observed that gingival inflammation was consistently present at sites showing obvious signs of recession. In addition, because several of the studies did not include assessments describing the gingiva, differences in the width of gingiva at the experimental sites may also have accounted for the variability observed in the response of the marginal soft tissue to orthodontic tooth movement. The prevailing opinion has been that a narrow or “inadequate” gingival zone is the reason for observed soft tissue reces-
sions in conjunction with orthodontic tooth movement.

Steiner et al speculated on mechanisms by which gingival tissue could be lost as a result of labial tooth movement and suggested that tension in the marginal tissue created by the forces applied to the teeth could be an important factor. If this hypothesis is valid, obviously the volume (thickness) of the gingival tissue at the pressure side, rather than its apico-coronal width, should determine whether or not soft tissue recession will develop during orthodontic therapy. To test this hypothesis, an experimental study was performed in monkeys in which teeth were orthodontically moved into areas with varying thickness and quality of the soft tissues. Following extensive bodily movement of incisors in a labial direction through the alveolar bone (Fig 6), most teeth showed clinically some apical displacement of the gingival margin as well as loss of probing attachment, but no loss of connective tissue attachment when evaluated histologically (Fig 7). The apical displacement of the gingival margin was minute and the result of a reduced height of the free gingiva only. Histological evaluation showed that the size of the free gingival unit was considerably smaller at the labially moved incisors, not only in the apico-coronal but also in the bucco-lingual direction, than at the orthodontically untreated control teeth. It is most likely that these dimensional changes of the gingival tissue at the pressure side, in the presence of an alveolar bone dehiscence, were related to tension, ie, stretching, developing in the soft tissues during the facial tooth movement. As a result of this reduction of the thickness and the height of the free gingiva,

Figure 6. (A) Occlusal view of the maxillary jaw in a monkey showing the position of the central incisors before (A) and after (B) the bodily movement in a labial direction. The canines and lateral incisors were joined in an individually fabricated silver splint and used as anchorage teeth. (B) The buccal aspect of the same incisors before (C), and after (D), the labial tooth movement. No change in the location of the gingival margin has occurred despite the pronounced labial displacement of the incisors. (Reprinted with permission from Wennström et al., 1987, Munksgaard International Publishers Ltd, Copenhagen Denmark.)
the soft tissue may offer less resistance to periodontal probing. This in turn may explain why some loss of probing attachment has been reported in most clinical studies on the effects of orthodontic therapy, whereas histological studies have noted that orthodontic forces per se will not induce loss of connective tissue attachment.

Similar to results presented by Foushee et al. from a study in humans, no relationship was found between the initial apico-coronal width (height) of the gingiva and the degree of apical displacement of the soft tissue margin during orthodontic therapy. Hence, these studies do not lend support to the hypothesis that a certain zone of gingiva is essential for the prevention of recession during orthodontic therapy, but rather corroborate observations reported by Coatoam et al., suggesting that the integrity of the periodontium can be maintained during orthodontic therapy also in areas that have only a minimal zone of gingiva.

The connection between gingival inflammation and soft tissue recession reported by Steiner et al., was also evident in the study by Wennström et al. Because it has been reported that, in the presence of a plaque-induced suprabony lesion, orthodontic forces per se during bodily movement are incapable of causing accelerated destruction of the connective tissue attachment, it may be assumed that stretching of the facial gingiva resulting in decreased bucco-lingual dimension of the border tissue, may favor the destructive effect of the plaque associated inflammatory lesion. This assumption is validated by the observations that, in the presence of plaque-induced gingivitis, a thin marginal soft tissue is more susceptible to complete breakdown than a thick one. Furthermore, because attachment loss was similar for plaque-infected teeth that had been bodily moved within the alveolar bone irrespective of the type of soft tissue (gingiva or alveolar mucosa), the thickness rather than the quality of the marginal soft tissue on the pressure side of the tooth seems to be the determining factor for the development of recession defects during orthodontic therapy in plaque-infected dentitions. However, in this context, extensive tipping and intrusive orthodontic forces may promote loss of attachment by displacing supragingival plaque into a subgingival location. Hence, the results from these studies emphasize the importance of adequate plaque control during the course of orthodontic therapy.

Clinical Implications

Alterations in the mucogingival complex will occur during orthodontic tooth movement, but these are independent of the apico-coronal width (height) of the gingiva. In terms of changes in the position of the soft tissue margin and gingival dimensions, the important factors to consider are the direction of the tooth movement and the bucco-lingual thickness of the gingiva.

Lingual tooth movement will result in an increased bucco-lingual thickness of the tissue at the facial aspect of the tooth, which results in
coronal migration of the soft tissue margin (decreased clinical crown height). Consequently, in cases with a thin (delicate) gingiva caused by prominent position of the teeth (Fig 4), there is no need for a gingival augmentation procedure in advance of the orthodontic tooth movement. Neither, in the case of a recession type defect should a mucogingival surgical procedure, aimed at root coverage, be performed before the orthodontic therapy (Fig 5). The recession, as well as the dehiscence, will decrease as a consequence of the lingual movement of the tooth into a more proper position within the alveolar bone, and if still indicated at that time, the surgical procedure will have a higher predictability of success than if it was performed before the tooth movement.

Facial tooth movement, on the other hand, will result in a reduced bucco-lingual tissue thickness and thereby a reduced height of the free gingival portion, and an increased clinical crown height. However, recession type defects will not develop as long as the tooth is moved within the envelope of the alveolar process. If the tooth movement is expected to result in the establishment of an alveolar bone dehiscence, the volume (thickness) of the covering soft tissue must be considered as a factor that may influence the development of soft tissue recessions during, as well as after, the phase of active orthodontic therapy. Orthodontic tooth movement per se will not cause soft tissue recession, but the thin gingiva that will be the consequence of the facial tooth movement may serve as a locus minorus resistentia to developing soft tissue defects in the presence of bacterial plaque and/or trauma caused by improper toothbrushing techniques. Before the orthodontic therapy is initiated, one should therefore carefully consider if the bucco-lingual thickness of the soft tissue on the pressure side of the tooth should be increased. Furthermore, instructions in adequate plaque control measures should be given and controlled before, during as well as after the completion of the orthodontic therapy to avoid unnecessary trauma to the tissue margin.

References

21. Schoo WH, van der Velden U. Marginal soft tissue


